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ABSTRACT

This paper asks whether manufacturers of high technology are locating production facilities in nonmetropolitan areas and, if so, which industries and geographical areas are affected. It identifies high-technology manufacturers and estimates national employment trends for the sector from 1975 to 1982. National and regional employment data for specific subsets of the high-tech sector are analyzed and high-tech development in the rural West is reviewed, focusing on the major high-tech industries and employment in 11 Western states. The document suggests that high-tech manufacturing helped decentralize national employment from 1975 to 1982. Rural employment in the sector increased, indicating an urban-to-rural shift. The different geographical regions did not equally share new high-tech employment. Rural areas of New England, Pacific, Mountain, and West South Central states saw benefits. The Mid-Atlantic and East North Central states showed a decline. New England and the Pacific states attracted more innovative high-tech manufacturers. Mature, high-tech industries are shifting employment to rural counties with low land and labor costs. Industries in growth and innovative stages remain close to metropolitan areas with skilled labor and specialized inputs. The high-tech industries are a potential source of rural employment. However, it is suggested that communities not concentrate their efforts on the sector. Mature firms are not likely to generate community development impact due to their limited employment and slow growth. (TES)

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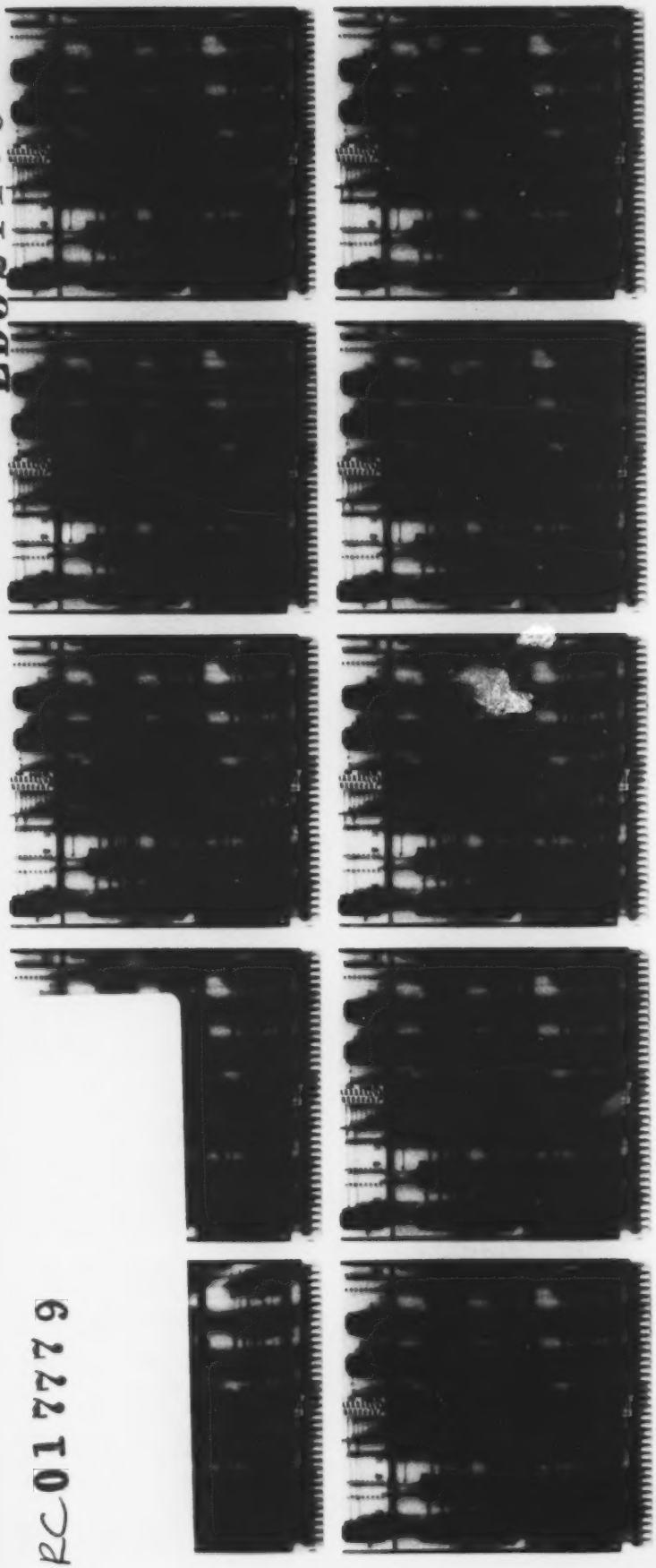

The Potential for High Technology Manufacturing in Nonmetropolitan Areas

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COMMUNITY ECONOMICS

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The Potential for High Technology Manufacturing in Nonmetropolitan Areas

Employment has significantly declined in many nonmetropolitan areas during recent years due to depressed conditions in the agricultural, mining, and forestry industries and to plant closings in the traditional manufacturing sectors. To replace jobs lost in these communities, local and state industrial development efforts have focused on high technology industries as a desirable source of new jobs and basic income. High technology manufacturers are being pursued aggressively for three reasons. First, they have rapid employment growth, and jobs in this sector are projected to grow much more rapidly than employment in most other manufacturing sectors. Second, high technology industries tend to be more labor intensive than other manufacturing sectors. Finally, the high technology sector is perceived to provide attractive working environments and employment opportunities for skilled and professional labor.

Although rural areas have traditionally had relatively little success in attracting or generating employment in high technology manufacturing, the product-life-cycle theory of industrial location suggests that this may be changing. In 1982, 88.6 percent of U.S. high technology employment was located in metropolitan areas, and 55.9 percent of this sector's employment was located in urban centers with populations exceeding one million. However, the product-life-cycle theory proposes that manufacturer's production processes evolve through distinct stages, and that these changes in production technology will alter the requirements for an optimal location.

During the "early" or "innovative" phase of the cycle, industries are characterized by rapid growth, relatively high product prices and profits, a relatively skilled labor force, a high proportion of scientific and engineering inputs, and a reliance on "outside" business services. During this phase, corporate priorities include maximizing market outreach and market shares, and locating near principal markets, specialized goods and services, and skilled labor (i.e., urban areas).

As new firms are attracted to the industry over time, however, the increased competition reduces profits. In addition, production technology becomes more standardized and, as a result, labor skill requirements and employment growth rates decline as many services are internalized. During this "mature" phase, industry employment decentralizes in an effort to reduce production costs and maintain "acceptable" profit margins. The existence of multi-plant firms in an industry further encourages decentralization, since those branches engaged in only the most routine operations can be relocated to rural areas.

Thus, the product-life-cycle theory suggests that nonmetropolitan communities will be viable locations for the highly routinized operations of mature manufacturers desiring to reduce production costs.[1]

The purpose of this paper is to determine if high technology manufacturers have relocated employment to nonmetropolitan areas, and if so, which industries and geographical areas have participated in the decentralization process. The organization of the paper is as follows. First, high technology manufacturing industries are identified, and data sources are specified. Second, 1975 to 1982 national employment trends for the high technology manufacturing sector are estimated. Employment change will be provided for nonmetropolitan counties of different population sizes, adjacency status, and census regions. Also, national and regional employment data for specific subsets of the high technology sector (2 digit SIC industrial groupings, "innovative" industries, "defense-related" manufacturers) will be analyzed. Third, the development of the high technology sector in the nonmetropolitan west is reviewed.

The eleven contiguous western states were selected for more detailed analysis because nonmetropolitan areas in this region have experienced the most rapid growth in high tech employment.[2] Nonmetropolitan high technology employment data is provided for each of the western states, and the dominant high technology industries in each state are identified. Also, the locational propensities of western, nonmetro, high technology firms are examined. The high technology manufacturers are divided into plant-structure categories (single-unit plants, branches of multi-plant firms) to determine if high tech entrepreneurs and branch

[1] For additional information on the product-life-cycle theory of industrial location, refer to Vernon (1966), Thompson (1969), Norton and Rees (1979), and Markusen (1985).

[2] The eleven Western states covered by this study are Arizona (AZ), California (CA), Colorado (CO), Idaho (ID), Montana (MT), Nevada (NV), New Mexico (NM), Oregon (OR), Utah (UT), Washington (WA), Wyoming (WY).

plants have similar locational criteria. Finally, the conclusions and policy implications of the study are provided.[3]

High Technology Manufacturing Defined

The number of alternative definitions of high technology industries is approximately equal to the number of studies focusing on the high technology sector. Accepting the necessary arbitrary nature of these classifications, this study selected the definition developed by Armington, Harris, and Odle (1983) of the Brookings Institution. The Brookings study classified an industry as high technology if: (1) more than 8 percent of their employees were in scientific, engineering and technical occupations and at least 5 percent of industry employment was in the more narrow class of scientific and engineering occupations; or (2) expenditures for research and development relative to product sales exceeded the national average. Twenty-four manufacturing industries (3 digit SIC) were identified as high technology using the above criteria (Table 1). Employment estimates for these high technology industries in 1976 and 1982 were provided by the National Planning Data Corporation's Enhanced County Business Patterns (NPDC-ECBP).[4]

Important subsectors of the high technology industries are the "innovative" manufacturers and those manufacturers producing goods for the U.S. military or space programs. The product-life-cycle theory suggests that the rapidly growing, skilled-labor intensive, "innovative," high technology industries will not participate in the decentralization process. Also, Markusen, et al. argue that the defense-related industries are unlikely candidates for employment decentralization because these manufacturers are less sensitive to cost differentials and more preoccupied with performance. To determine if "innovative" and "defense-related" industries are reluctant to select rural locations, members of these high technology subsectors were identified and nonmetropolitan employment trends were estimated. "Innovative" industries were defined as the high technology manufacturers with the highest labor skill requirements and historically dramatic employment growth rates. Specifically, the criteria for classification as "innovative" were: (1) research and development expenditures to net sales ratios at least twice the national average (Riche, et al.,

Table 1. High Technology Manufacturing Industries

Standard Industrial Code	Industry Group
281	Industrial inorganic chemicals
282	Plastic materials, synthetics
283	Drugs
286	Industrial organic chemicals
289	Miscellaneous chemical products
291	Petroleum refining
348	Ordnance and accessories, n.e.c.
351	Engines and Turbines
353	Construction and related machinery
356	General industrial machinery
358*	Office and computing machines
362	Electrical industrial apparatus
365	Radio and TV receiving equipment
366*	Communication equipment
367*	Electronic components, accessories
372*	Aircraft and parts
376*	Guided missles, space vehicles
381	Engineering, scientific instruments
382*	Measuring and control devices
383	Optical instruments and lenses
384*	Medical instruments and supplies
385	Opthalmic goods
386	Photographic equipment and supplies
387	Watches and clocks

* "Innovative" high-technology manufacturing industries.

[3] Throughout this paper, metropolitan and urban refer to Standard Metropolitan Statistical Areas (SMSA's). Rural and nonmetropolitan will be used interchangeably to refer to non-Standard Metropolitan Statistical Areas (non-SMSA's).

[4] The enhanced County Business Patterns is a data file created by the National Planning Data Corporation (Ithaca, N.Y.) through additional processing of the County Business Patterns (CBP) that involves estimating suppressed data. The suppressed or missing four digit industry employment levels for a county are estimated using the mathematical technique known as "Interactive Proportional Fitting." These estimates are within the range specified by the suppression flag (e.g., county employment in SIC 3531 is in the range 500-999), and the estimates have been adjusted (up or down) so that any "filled in" numbers are internally consistent with other unsuppressed county or state subtotals and totals in the CBP file. Also, "real" or "unsuppressed" data that appear on the original CBP tapes were never changed. A description of the NDPC's Interactive Proportional Fitting technique and consistency checks is available upon request from the authors.

1983), or at least 10 percent of the work force in scientific or engineering occupations (Brennan, 1983); and (2) post-World War II compound annual employment growth rates in excess of 3 percent and growth that had not peaked as of 1981 (Markusen, et al., 1986). Seven of the 24 high technology manufacturers were identified as being in their "innovative" phase using the above two criteria (see Table 1). The remaining 17 high technology industries are categorized as industries in the "mature" or "declining" stages of their product life cycles. The defense-related manufacturers are those four-digit SIC industries identified by Henry (1983) as having more than 25 percent of their 1982 output purchased by the Defense Department. The twelve four-digit SIC industries in this defense-related sector include the producers of explosives, ammunition and ordnance, radio and TV transmitting equipment, aircraft and missiles, and scientific instruments.[5]

Employment Trends for the U.S.

County size and adjacency status. The 1975 and 1982 total manufacturing and high technology manufacturing employment change for four metropolitan county classifications (large central, large fringe, medium, small) and four nonmetropolitan county categories (large adjacent; large, not adjacent; small adjacent; small, not adjacent) are provided in Table 2. The employment data indicate that: (1) all size and adjacency groupings experienced employment growth in manufacturing as a whole and in the high technology sector; (2) high technology employment growth rates exceeded the growth rates of manufacturing in general for each county classification; and (3) nonmetropolitan employment in high technology industries increased rapidly (14.8 percent) from 1975 to 1982, though not as rapidly (22.6 percent) as this sector's employment growth in metropolitan areas. Thus, while employment in manufacturing is decreasing in importance relative to other sectors, high tech manufacturers are going against this trend and are experiencing very rapid growth.

The growth rates of high technology manufacturers were not uniform across county size and adjacency categories. High technology employment growth rate in the small nonmetropolitan counties (urban population < 20,000) was approximately twice that estimated for the large nonmetropolitan counties (urban population > 20,000). Also, small (population < 250,000) and medium-sized (population 250,000 - 1,000,000) metropolitan areas and the fringe counties of the largest SMSA's all had high technology growth rates greater than the rate estimated for the central counties of the largest SMSA's (population > 1,000,000).[6] Interestingly enough, after controlling for county population, high tech employment growth in non-

[5] The industries (4 digit SIC's) specified as defense-related were: explosives (SIC 2892), small arms ammunition (SIC 3482), ammunition (SIC 3483), ordnance and accessories (SIC 3489), radio-TV transmitting (SIC 3662), aircraft and guided missiles (SIC 3721, 3724, 3728, 3761, 3764, 3769), and engineering, lab, and science research instruments (SIC 3811). Refer to Henry (1983) for a discussion of the importance of defense spending for manufacturing industries.

Table 2. High Technology Manufacturing Employment in Metropolitan and Nonmetropolitan Counties, 1975-1982.

County Classification	Employment Totals 1975	Employment Totals 1982	Percentage Change in Employment High Tech	Percentage Change in Employment All Mfg.	Employment Shift
Metropolitan					
Large					
Central Counties	1,391,777	1,631,523	17.2%	3.7%	-115,852
Fringe Counties	660,439	876,648	32.7	15.8	40,304
Medium	888,941	1,102,654	24.0	7.0	40,163
Small	299,834	362,064	20.8	5.9	21,626
Total	3,240,991	3,972,889	22.6	7.4	- 13,759
Nonmetropolitan					
Large					
Adjacent	176,603	192,313	8.9	2.3	- 8,278
Not Adjacent	67,667	75,700	11.9	9.8	1,366
Small					
Adjacent	103,688	130,353	25.7	19.2	13,370
Not Adjacent	102,637	119,050	16.0	14.1	7,300
Total	450,595	517,416	14.8	11.0	13,758

metro counties was not consistently related to county adjacency status. Large counties adjacent to metro areas had relatively slow high tech employment growth (8.9 percent) while the growth rate for small adjacent counties (25.7 percent) was very high.

A shift-share analysis of the NPDC-ECBP data indicates that much of the high tech employment growth in the various county category sectors could be attributable to the existing industries growing at their respective national rates (share component). However, for some county classifications, employment decentralization (or shift) was an important component of change in high technology manufacturing employment.[7] For example, high technology employment in the central counties of the large metropolitan areas increased by more than 244,000 from 1975 to 1982, yet, an increase of over 360,000 jobs would have resulted if these counties' share of national employment had been maintained. Thus, the large metropolitan areas' central counties actually "lost" over 115,000 jobs relative to what would have been realized if these counties' industries had grown at their respective national rates. These jobs "lost" by the central counties were distributed primarily to the metropolitan fringe counties, and to medium and small metropolitan areas. There were also high technology employment gains of almost 21,000 due to employment decentralization in the less populated nonmetropolitan areas.

However, the large, adjacent, nonmetropolitan counties experienced a negative shift of over 8,000 jobs. High technology employment is growing rapidly in nonmetropolitan areas, and part of this growth is due to an urban-to-rural shift in the industry. Furthermore, this redistribution of employment does not appear to be simply a case of "suburbanization." Both adjacent and non-adjacent, small, nonmetropolitan counties experienced positive employment shifts from 1975 to 1982.[8]

Industry type. Most U.S. employment in high technology manufacturing was in the non-electrical machinery (SIC 35) and electrical equipment (SIC 36) industries. These two industrial sectors also were the principal high tech employers in both metro and nonmetro areas. Figure 1 shows, however, that metro and nonmetro counties exhibited different subsector specializations. Metropolitan high technology employment was more heavily concentrated in the electronic equipment (SIC 36) and transportation industries (SIC 37) than employment in the nonmetro counties. On the other hand, nonmetropolitan areas had relatively heavy employment concentrations in the chemicals (SIC 28) and non-electrical machinery (SIC 35) high technology firms. Employment shares in the instruments (SIC 38), petroleum (SIC 29), and fabricated metals (SIC 34) industries were similar between metro and nonmetro counties.

The growth rates of metro and nonmetro high technology employment also varied significantly by industry type (Figure 2). Metropolitan employment growth was relatively rapid in the non-electrical machinery (SIC 35), electrical equipment (SIC 36), and instruments industries (SIC 38), but rural areas experienced relatively rapid employment growth in the high technology members of the transportation (SIC 37) and chemicals (SIC 28) industries. Employment growth in the petroleum (SIC 29) and fabricated metals (SIC 34) industries was slow or negative for both metro and nonmetro areas.

[6] The urban population of nonmetropolitan counties consists of all persons living in: (a) places of 2,500 inhabitants or more incorporated as cities, villages, boroughs, and towns, but excluding those persons living in the rural portions of extended cities; (b) unincorporated places of 2,500 inhabitants or more; and (c) other territory, incorporated or unincorporated, included in urbanized areas.

[7] The measure of employment shift used in this study is the "shift" component of shift-share analysis. Specifically,

(1)

$$S_{ij} = E^{t}_{ij} - E^{t-1}_{ij} \left(\frac{US^{t}_{i}}{US^{t-1}_{i}}\right)$$

and

(2)

$$Share_{j} = \sum_{i} Share_{ij}$$

where:

Sij = employment shift for four digit SIC industry i, region
j;Sj = employment shift for region
j;Eij = industry's employment in area
j;USi = United States employment in industry i;
t,t-1 = 1982 and 1975, respectively.

The "shift" measure Sij represents the difference between the actual 1982 industry employment in a region (or counties of a specified classification) and the employment level that would have occurred if the region's industry had realized the nation's growth rate for that industry. A $S_{ij}>O$ will be interpreted as a "shift" or "relocation" of industry i into region j. A positive S_{ij} also indicates an increase in the concentration of industry i's employment in region j. Alternatively, a $S_{ij}<O$ reflects a relative shift of employment out of region j, and as a result, a decline in the region's share of employment in industry i.

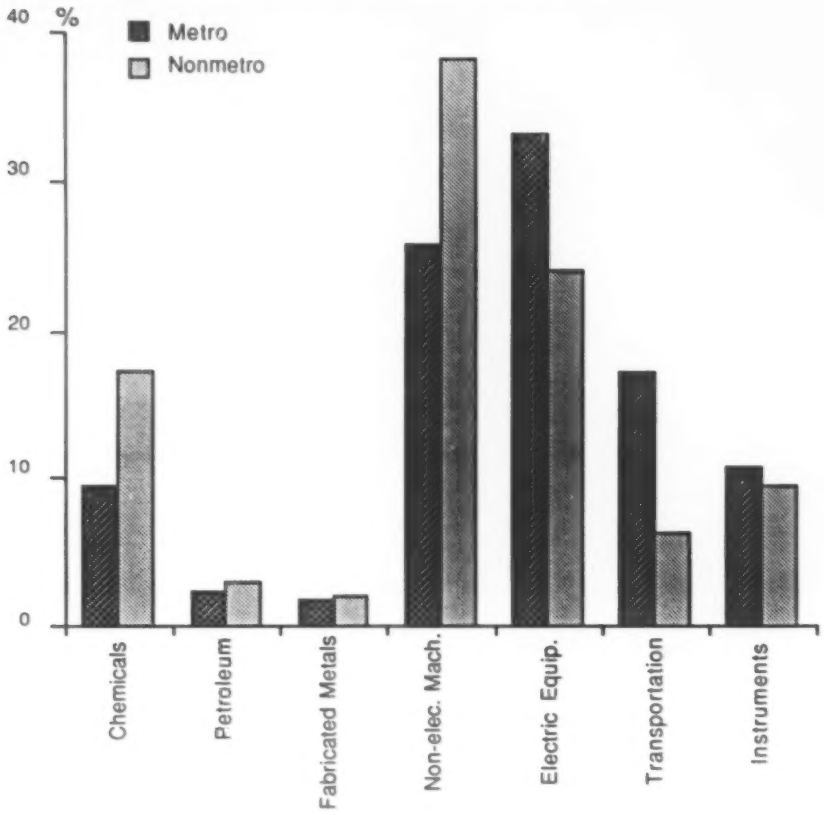
The "share" component for industry i in region j is the employment change that would have occurred if the region's industry had experienced the nation's growth rate for that industry. That is:

$Share_{ij} = E^{t-1}_{ij} [(US_{t} / US_{t-1}) - 1]$ and $Share_{j} = \sum_{i} Share_{ij}$

Thus, the measure $Share_{j}$ includes both the "mix" and "national growth" components of the traditional three component shift-share analysis.

[8] The shift-share analysis was estimated at the four-digit SIC level and only 75 of the 81 four-digit high tech industries had complete employment data. Thus, the sum of the "shift" and "share" components of employment change do not equal the difference between the 1975 and 1982 employment totals provided in Table 2.

Figure 1. Distribution of metro and nonmetro high technology employment by industrial sector, United States, 1982



These findings indicate that high technology employment in the chemicals and transportation industries has decentralized to rural areas, while the urban concentration of the electrical, non-electrical machinery, and instruments industries has increased.

Another interesting distinction between high tech manufacturers in metro and nonmetro areas is the relative importance of "innovative" and "defense-related" industries (Figure 3). High technology manufacturing employment in the metropolitan areas had a relatively high concentration of the rapidly growing, skilled-labor intensive, "innovative" industries. Almost 60 percent of metro high tech employment was in innovative industries, while innovative industries comprised only 36 percent of the sector's nonmetro employment. Moreover, the urban concentration of innovative manufacturers increased slightly from 1975 to 1982, due to more rapid employment growth among these industries in metropolitan (41.5 percent) than nonmetropolitan (38.4 percent) areas. The space and defense-related manufacturers also provided relatively more high tech jobs in metro than nonmetro counties. Defense-related industries were responsible for 31.0 percent of metro area high tech jobs while only 13.9 percent of rural area high tech employment was generated by this sector. In addition, the growth of defense-related employment in rural areas (15.9 percent) was slow relative to that estimated for the metro counties (24.2 percent). Thus, in general, defense spending and the defense-related industries played a small role in the development of the high technology sector in nonmetropolitan counties.

Regional employment change. The previous discussion has shown that from 1975 to 1982 nonmetropolitan counties as a whole had been successful in attracting or generating employment in high tech industries. However, the high tech jobs decentralizing to rural areas were not distributed equally among the nonmetropolitan counties of the nine census regions (NE, MA, ENC, WNC, SA, ESC, WSC, MT, PAC). The specific types of industries (type of product, "innovative", mature, defense-related) that were locating employment in rural areas also varied greatly across regions.[9] Analysis of these regional employment growth differences provides further insight into the high tech decentralization process and the relevance of the product-life-cycle theory of industrial dispersion.

The regional employment data presented in Figure 4 indicate that the geographical redistribution of employment in the high technology industries was similar to spatial shifts observed for the U.S.

[9] The nine census regions are New England (NE), Middle Atlantic (MA), South Atlantic (SA), East North Central (ENC), West North Central (WNC), East South Central (ESC), West South Central (WSC), Mountain (MT), and Pacific (PAC).

Figure 2. Growth rates of metro and nonmetro high technology employment by industrial sector, United States, 1975-82

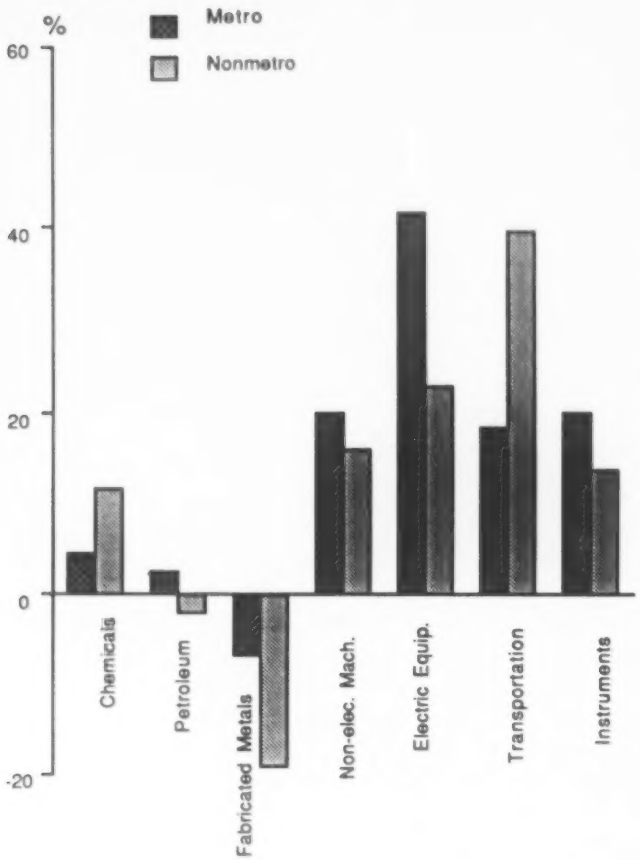
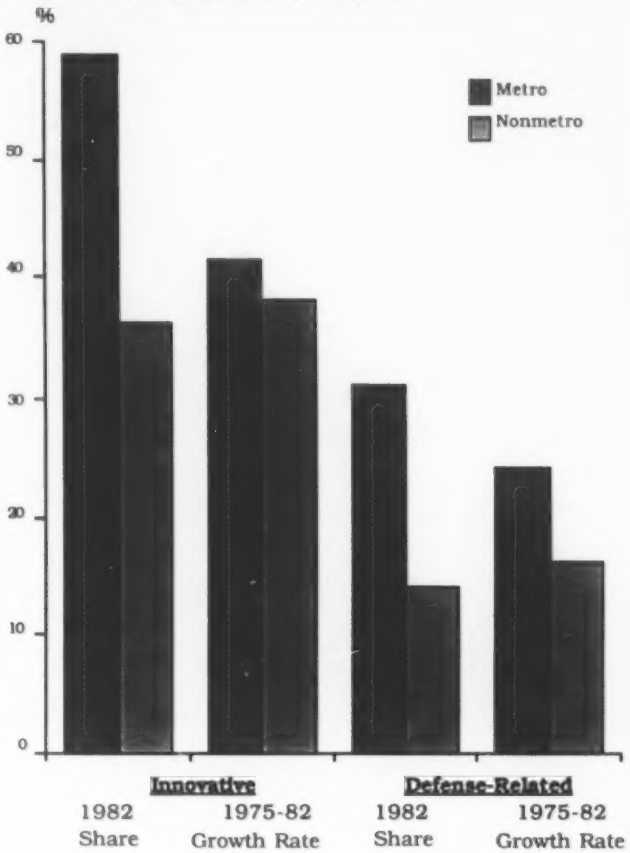


Figure 3. Percent of metro and nonmetro high tech employment in innovative and defense-related industries, United States, 1975-82



manufacturing sector as a whole.[10] Nonmetropolitan counties in the South and West generally experienced rapid high technology employment growth, while slow or negative growth rates were realized by rural areas in the Mid-Atlantic and East North Central regions. Thus, the principal beneficiaries of the decentralization of high technology employment were the nonmetropolitan counties in Southern and Western states, while the "losers" were primarily the urban centers in the traditional manufacturing belt. It is important to note, however, that a strict "Snowbelt-to-Sunbelt" redistribution did not occur. Nonmetropolitan counties in the New England and West North Central regions experienced rapid high technology growth rates, while employment growth for nonmetropolitan areas in the East South Central states were very low. Interesting regional similarities and differences also were evident with respect to the principal types of high technology manufacturing industries (3 digit SIC) locating in nonmetropolitan areas (Table 3). For example, in 7 of the 9 census regions (NE, MA, ENC, WNC, SA, MT, PAC), electronic components (SIC 367) was an important, nonmetropolitan, high tech employer. Also, general industrial machinery (SIC 356) was one of the three principal technical employers in every region except MT and PAC. Regional specialization existed in other types of industries. Petroleum refining (SIC 291) was important in the West (WSC, MT, PAC);

[10] Refer to Weinstein, Gross, and Rees (1985) for an excellent discussion of recent regional shifts in economic activity.

Figure 4. Distribution and growth of nonmetro high-tech employment by region, 1975-82

Table 3. Principal Nonmetro High Technology Manufacturing Industries, by Region, 1982

Region	Industrial Sector (3 digit SIC)		
New England	Electronic components accessories (24%)*	Aircraft and parts (19%)	General industrial machinery (16%)
Middle Atlantic	General industrial machinery (19%)	Electronic components, accessories (18%)	Construction and related machinery (17%)
East North Central	General industrial machinery (21%)	Engines and turbines (15%)	Electronic components, accessories (13%)
West North Central	Construction and related machinery (19%)	General industrial machinery 16%)	Electronic components, accessories (15%)
South Atlantic	Plastic materials, synthetics (25%)	General industrial machinery (11%)	Electonic components, accessories (10%)
East South Central	Plastic materials, synthetics (15%)	Construction and related machinery (12%)	General industrial machinery (12%)
West South Central	Construction and related machinery (26%)	General industrial machinery (15%)	Petroleum refining (11%)
Mountain	Guided missles, space vehicles (32%)	Electronic components, accessories (11%)	Petroleum refining (11%)
Pacific	Office and computing machines (25%)	Electronic components, accessories (21%)	Petroleum refining (10%)

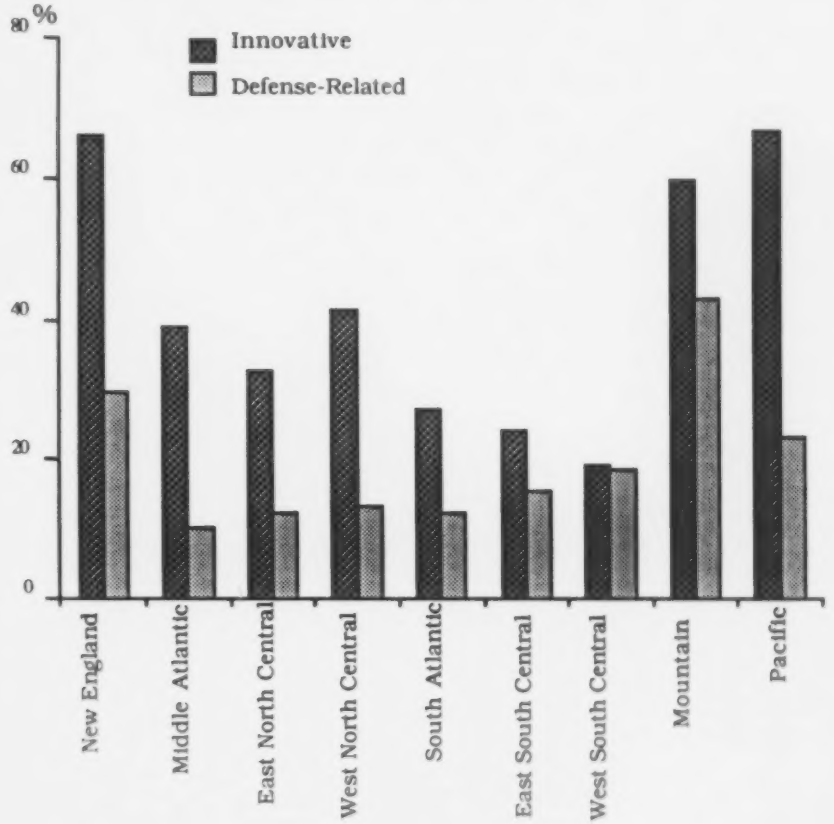
* Percent of the region's high technology employment in industrial sector.

plastic materials, synthetics (SIC 282) was the dominant high tech industry in the South (SA and ESC); and construction and related machinery (SIC 353) was a significant employer in the rural areas of the North (MA and WNC). Finally, nonmetropolitan areas in the West and New England had relatively large employment in the more "glamorous" aircraft (SIC 372), guided missiles (SIC 376) and office and computing machines (SIC 357) industries.

The nine census regions also differed significantly in the relative importance of innovative and defense-related industries in their high tech sectors (Figure 5). Innovative industries comprised a large proportion of the sector's nonmetropolitan employment in the Pacific (66.8 percent), New England (66.1 percent), and Mountain states (59.6 percent), but relatively little of the high tech employment in the South Atlantic (27.0 percent), East South Central (24.2 percent), and West South Central (19.1 percent) regions. These findings indicate that the decentralization of "innovative" manufacturers was limited primarily to rural areas with greatest proximity to urban centers where these activities have agglomerated. More specifically, rural areas near Boston (NE), "Silicon Valley," and Los Angeles (PAC, MT) realized by far the greatest shares of employment from innovative industries.

Employment in defense-related high tech manufacturing also was not distributed proportionately among the regions (Figure 5). Space and defense-related industries were an important component of the nonmetropolitan high tech sector in the Mountain (42.6 percent) and New England (29.6 percent) states. However, in the Middle Atlantic, East North Central, West North Central and South Atlantic regions, the defense-related manufacturers never contributed more than 14 percent of the rural areas' high tech employment. Thus, only nonmetropolitan communities near military installations or weapons test sites (MT) or major research centers (NE) have had limited success in attracting defense-related employment.

Figure 5. Percent of nonmetro high technology employment in innovative and defense-related industries by region, 1982



High Technology Manufacturing in the West

The eleven contiguous western states (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) have been relatively successful in attracting and generating high technology manufacturing employment (Table 4). This employment was concentrated in California; however, Arizona, Colorado, and Washington also developed significant employment in this sector. Job growth rates exceeded 40 percent from 1975 to 1982 in all the western states, and the total high tech job growth during that period for the region was in excess of 350,000.

Nonmetropolitan counties in the west also benefited from the regional growth in high technology employment. All states except Nevada experienced rapid employment growth in these industries from 1975 to 1982, and over 13,000 high tech jobs were added to western rural areas during this period. Nonmetropolitan areas in Oregon, California, Utah, Arizona, Idaho, and New Mexico experienced the greatest gains in

Table 4. High Technology Manufacturing Employment in the Western States, 1975-82.

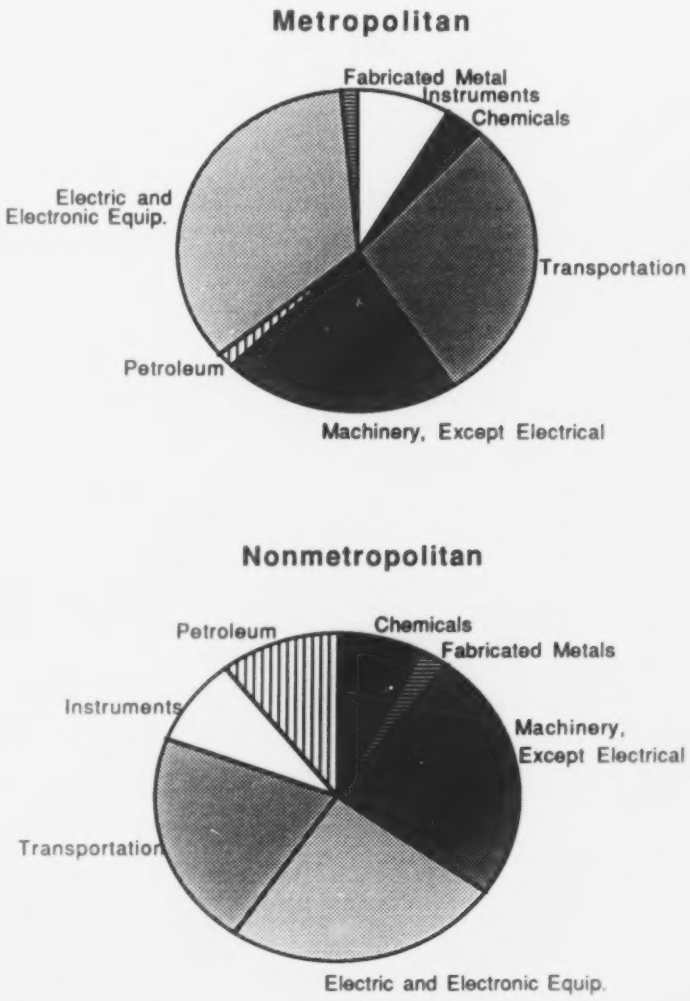
	Metropolitan			Nonmetropolitan		
State	1975	1982	% Change	1975	1982	% Change
Arizona	39,728	73,836	85.9%	956	1,777	85.9%
California	538,498	782,101	45.2	2,029	4,175	105.8
Colorado	30,727	65,532	113.3	1,142	1,596	39.8
Idaho	189	1,647	771.4	1,545	2,807	81.7
Montana	766	925	20.8	392	718	83.2
Nevada	817	2,906	255.7	597	301	-49.6
New Mexico	4,061	7,791	91.8	1,182	2,110	78.5
Oregon	14,730	21,071	43.0	1,250	4,498	259.8
Utah	14,274	26,218	83.7	2,881	5,605	94.6
Washington	61,550	90,393	46.9	2,064	2,744	32.9
Wyoming	829	1,285	55.0	447	1,279	186.1

high technology employment, all exceeding 75 percent. However, despite this rapid growth, high technology manufacturers are not as yet a major source of employment in the nonmetropolitan areas of most western states. Only 27,610 high tech jobs existed in the nonmetro west in 1982 and 14,278 (52 percent) of these jobs were in nonmetro counties in California, Oregon, and Utah.

Industry type. It was noted previously that the high technology manufacturers in the rural west are not representative of firms attracted to other regions because of the relatively high concentration of "innovative" and "defense-related" industries in the region. More than three out of every five western, nonmetropolitan, high tech jobs were in innovative industries, and one-third of this sector's rural employment was in defense-related industries. The relatively high employment in these two subsectors reflects the industrial structure for the region's metropolitan areas. In 1982, innovative and defense-related industries had 82.7 percent and 45.6 percent, respectively, of the western, metropolitan, high technology manufacturing employment. Thus, much of the innovative, and defense-related, high technology employment in western rural areas is attributable to (1) geographic proximity to major technical centers such as San Francisco/San Jose, Los Angeles/San Diego, Seattle, and Denver; (2) proximity to major military installations, and (3) availability of open spaces for weapons testing.

The industrial compositions of the western metropolitan and nonmetropolitan high technology sectors reflect specializations that are generally associated with urban and rural economies (Figure 6). Metropolitan areas exhibited higher employment shares than nonmetro counties in the electronics (34.8 percent vs 24.6 percent) and transportation (28.8 percent vs 21.5 percent) industries. High tech employment in the (1) chemicals and allied products, (2) petroleum products, and (3) machinery, except electrical industries was relatively more important in nonmetropolitan areas (42.4 percent vs 26.5 percent). These findings reflect the bias of western, nonmetro areas towards resource-oriented firms and manufacturers of specialized machinery for these indus-

Figure 6. Distribution of western high-tech employment by industrial sector, 1982



tries. The 1975-82 industrial growth rates indicate, however, that the urban-rural differences in specialization may be narrowing (Figure 7). Rural areas experienced very rapid employment growth in the electronic equipment (157.3 percent), non-electrical machinery (137.1 percent), and transportation equipment (98.8 percent) industries. Thus, nonmetropolitan communities' dependence on resource-based, high technology industries may be decreasing.

Additional insight into the nonmetropolitan high tech sector is provided by examining the principal high tech manufacturers (3 digit SIC) for each state's nonmetropolitan areas (Table 5). The employment data indicate that in three of the eleven western states (New Mexico, Washington, Wyoming), nonmetropolitan high tech employment is largely the result of the significant presence of the petrochemicals industry. Nonmetropolitan areas in California, Colorado, Idaho, Montana and Nevada were similar, in that electronic components, accessories, and apparatus manufacturers were important nonmetropolitan employers in these states. Other employers of significance in these five states include the manufacturers of measuring and control devices, construction machinery, and communication equipment. Finally, nonmetropolitan areas in Oregon, Arizona, and Utah have developed high tech sectors unlike other western states. Arizona's nonmetropolitan technical sector is relatively diversified, with the medical instruments and plastics materials industries providing the greatest employment. The office

Figure 7. Metro and nonmetro high technology manufacturing growth rates by industrial sector, western states, 1975-82

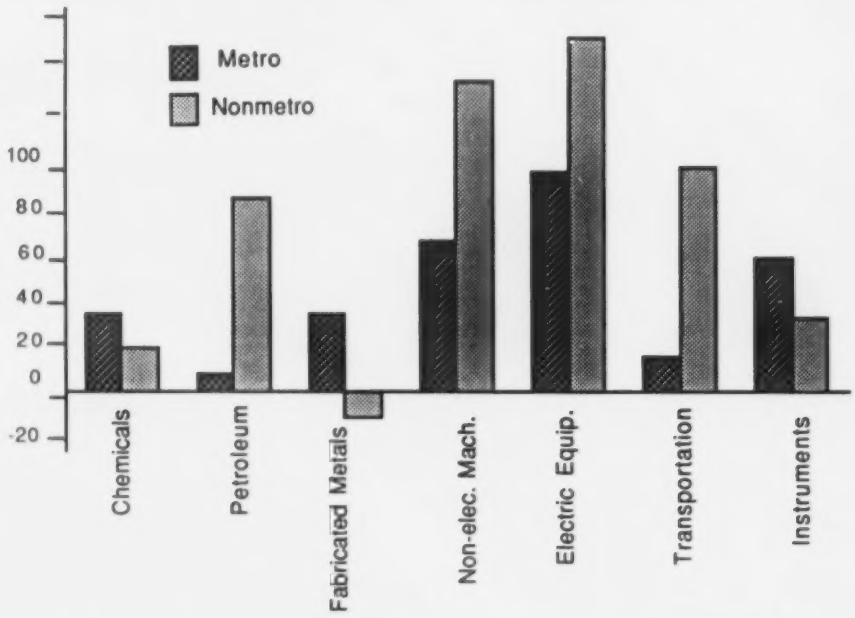


Table 5. Principal High Technology Manufacturing Industries, Western Nonmetropolitan Counties, 1982

State	Industrial Sector (3 digit SIC)		
Arizona	Medical instruments & supplies (26%)*	Plastics materials synthetics (14%)	Misc. chemical products (13%)
California	Electronic components, accessories (49%)	Communication equipment (21%)	Misc. chemical products (11%)
Colorado	Electronic components, accessories (29%)	Measuring & control devices (29%)	Petroleum refining (11%)
Idaho	Electronic components, accessories (36%)	Ordnance and accessories (22%)	Construction and related mach. (21%)
Montana	Electrical industrial apparatus (29%)	Construction and related mach. (15%)	Medical instruments and supplies (14%)
Nevada	Measuring & control devices (33%)	Electronic components and apparatus (23%)	
New Mexico	Petroleum refining (32%)	Construction and related mach. (24%)	Measuring and control devices (18%)
Oregon	Office & computing machines (56%)	Communication equipment (12%)	
Utah	Guided missiles, space vehicles (92%)		
Washington	Petroleum refining (27%)	Construction and related mach. (27%)	Office & computing machinery (12%)
Wyoming	Petroleum refining (49%)	Construction and related mach. (14%)	Office and computing machinery (13%)

* Percent of state's nonmetropolitan high technology employment in industrial sector. Only industries with ten percent or more of the state's nonmetropolitan high technology employment are listed.

Figure 8. Total high tech employment, 1982

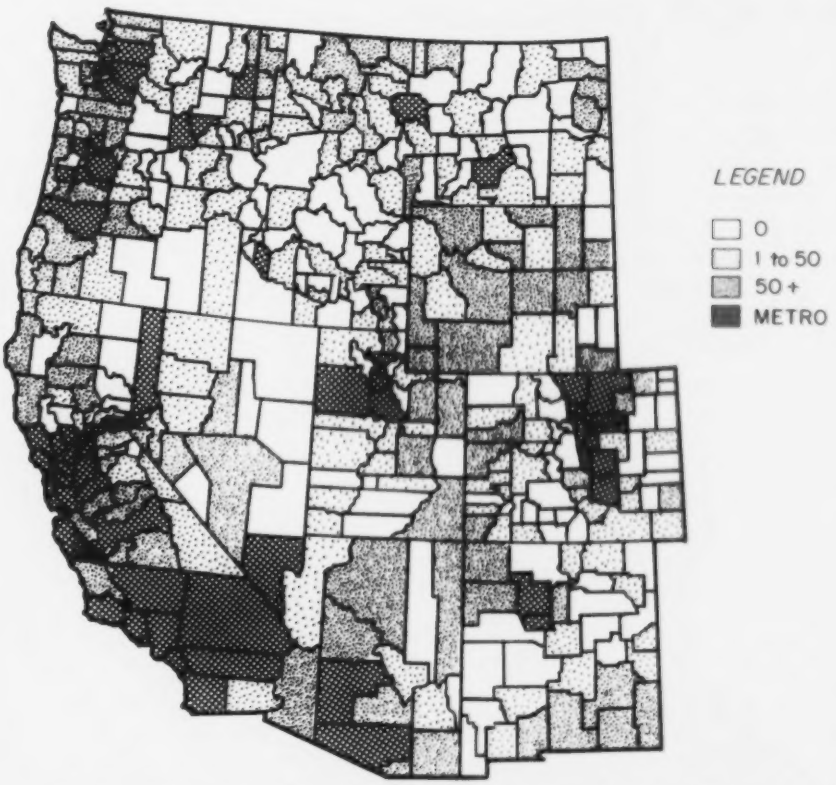


Table 6. Distribution of Nonmetro High Tech Employment by County Size and Adjacency, Status Western States, 1982.

County Population	Unit Plants		Branch Plants	
	Adjacent	Nonadjacent	Adjacent	Nonadjacent
Small (0-10,000)	.8% (17)*	1.3% (123)	.2% (17)	2.8% (123)
Medium (10,000-25,000)	1.1 (20)	6.6 (84)	1.7 (20)	5.5 (84)
Large (25,000 +)	18.4 (45)	14.4 (51)	27.5 (45)	19.5 (51)
Total	**20.3**	**22.3**	**29.4**	**27.8**

* Number of counties in the size-adjacency category.

and computing machines industry dominated nonmetropolitan, high tech employment in Oregon, and high tech employment in rural Utah consisted primarily of one large firm in the guided missiles and space vehicles industry.

Location of high tech firms. Employment in high technology manufacturing was not distributed uniformly among the 346 western nonmetropolitan counties (see Figures 8, 9 and 10). One hundred and nineteen of these counties (34.4 percent) had no employment in this sector in 1982, and only 110 of the rural counties (31.8 percent) had more than fifty employed in high tech manufacturing. Moreover, nonmetro high tech employment agglomerated primarily in the most populous nonmetro counties (Table 6). Almost 80 percent of the western rural technical employment was located in counties with populations greater than 25,000. The 140 nonmetro counties with populations less than 10,000, had only 5.1 percent of this sector's nonmetro employment.

Also, the high tech employment was more heavily concentrated in nonmetro counties adjacent to metro counties than in counties more remotely located from urban areas. The 82 adjacent nonmetro counties had 49.7 percent of the high tech employment, while the remaining 50.3 percent was distributed among the 258 nonadjacent nonmetro counties. This preference of the technical manufacturers for large, adjacent, nonmetro areas held for both locally-owned, unit plants, and for branches of multi-plant operations. Almost 50 percent of the unit and branch-plant employment was located in the 45 nonmetro counties with populations greater than 25,000 and with proximity to metropolitan areas.

The above data indicates that the larger, adjacent counties have been most successful in attracting high tech, branch-plant operations, and in generating indigenous high tech unit plants. To better identify the characteristics of nonmetro counties which have developed high tech manufacturing sectors, an econometric analysis was undertaken to determine if the 1982 level of county high technology employment was associated significantly with select nonmetropolitan county

characteristics. Twenty-three community factors were selected to represent (1) the county's size and location (1980 population, population change, adjacent to metro area, commuters to metro area, and distance to interstate highway); (2) the county's employment structure (percent employment in agriculture, percent employment in mining, percent employment in manufacturing, military installation present, university present, unemployment rate, and farm value); (3) the quality and availability of local services (government expenditures per capita, education expenditures per capita, and property tax rate) and (4) the availability of local amenities and the quality of life (crime rate, median family income, median value of homes, median school years, percent of population 65 and older, location on seacoast, recreation lake present, and January heating days).

The nonmetropolitan county, high tech employment data were disaggregated by plant ownership type (branch plants vs locally-owned, unit plants) to determine if the community factors associated with attracting branch plants differ from those related to the generation of indigenous concerns.[11]

The results of the statistical analysis for high tech branch and unit plants are summarized in Table 7. County employment in both high tech branch and unit manufacturing facilities was positively related to county population,

[11] Refer to Keith and Barkley (1988) for a complete discussion of the data and econometric techniques used in determining the importance of community factors for high tech location. The U.S. Establishment-Enterprise Microdata (USEEM) file was used for the county-level high tech employment data.

Figure 9. High tech branch plant employment, 1982

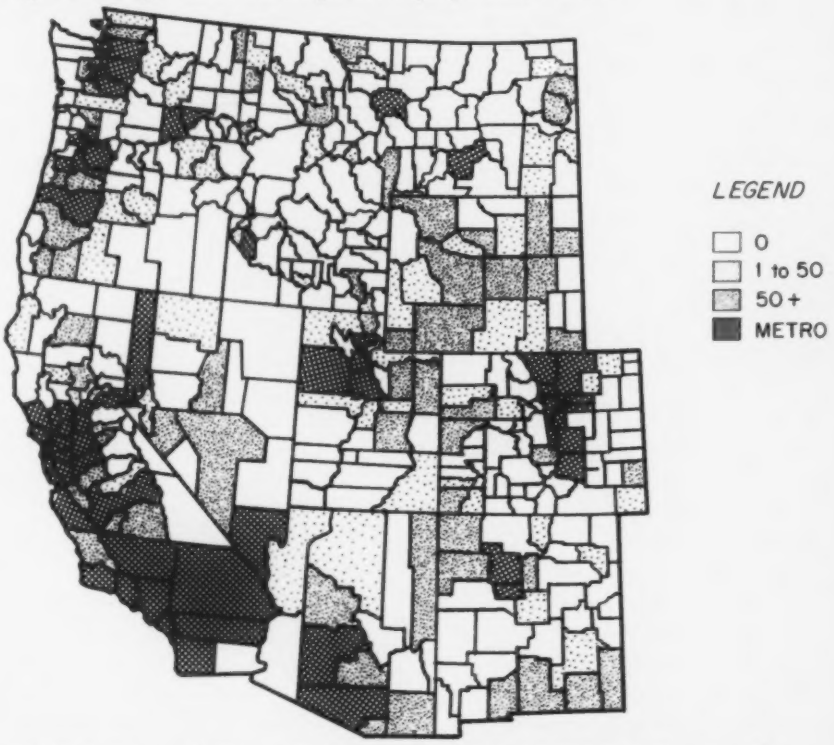
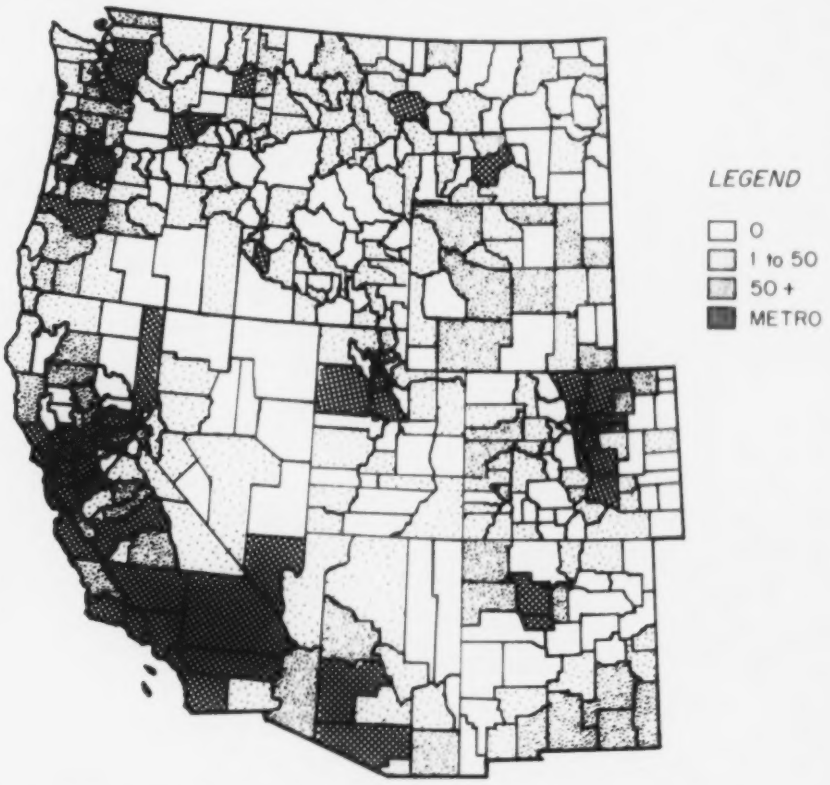


Table 7. Community Factors Statistically Associated with High Tech Plant Locations, Nonmetro West, 1982

	Branch Plants	Unit Plants
County Population*	+	+
Percent 65 and Older		
Population Change	+	+
Median School Years		+
University Present		–
Military Institution Present	–	–
Location on Seacoast		
Recreation Lake Present	–	+
January Heating Days	+	+
Median Family Income		
Crime Rate	–	–
Median Value Single Family Dwelling		
Government Expenditures Per Capita		
Education Expenditures Per Capita		
Property Tax Rate		+
Commuters to Metro Area	+	
Adjacent to Metro Area	+	+
Proximity to Interstate		
Percent Employment in Agriculture	–	–
Percent Employment in Mining		
Percent Employment in Manufacturing	–	–
Unemployment Rate		
Farm Value		+

* Only the signs of the significant coefficients (at the .10 level) are provided.

Figure 10. High tech unit plant employment, 1982



population growth rate, and proximity to metropolitan areas. These findings are consistent with the aggregated results reported earlier. The innovative, western, high tech firms have demonstrated a preference for locating in large nonmetro communities near the centers of high tech activity (e.g., San Francisco, Portland, Seattle, Los Angeles). Also, nonmetro counties with military installations or relatively large agricultural or manufacturing sectors had little high tech employment. Thus, both branch and unit high tech plants preferred nonmetro locations with relatively diversified economic bases.

Community services and amenities also were associated with plant location. However, the relationships differed for branch and for unit plants. Locally-owned, high tech plants were more prominent in counties with high property tax rates and high median school years. These results support the hypothesis that high tech, unit plants are more likely to develop or locate in areas with high quality public services and labor. Interestingly enough, employment in the unit plants was negatively associated with the existence of a university. This is inconsistent with the belief that universities may serve as an incubator for, or attractor of, small, high tech firms.

Employment in high tech branch plants was negatively associated with community crime rate. However, no significant relationship existed between branch plant employment and any of the proxy variables for the quality of local services (government expenditures, property tax rate) or the availability and quality of local education (university present, education expenditures, median school years). Thus, production at the branch plants does not appear to require locations with specialized services or a highly educated labor force. This is consistent with the observation that many of the high tech branch plants are engaged in relatively routine production operations (see Barkley, Dahlgran, and Smith).

Summary and Conclusions

This paper was an attempt to determine if high technology manufacturers are locating production facilities in nonmetropolitan areas, and if so, which industries and geographical areas are participating in this decentralization process. An analysis of employment trends for 24 three-digit manufacturing industries indicated that high technology manufacturing had decentralized employment from 1975 to 1982. Nonmetropolitan employment in this sector had increased from more than 450,000 to almost 520,000 from 1975 to 1982. Moreover, 13,000 of the new rural high tech jobs resulted from an urban-to-rural shift in this sectors' manufacturing activity.

The decentralizing high tech employment was not distributed proportionately among rural areas in different geographical regions or among counties of different population sizes. Employment declined in the sector in the nonmetro areas of the Middle Atlantic and East North Central states. Rural areas in the New England, Pacific, Mountain, and West South Central states saw 1975-82 employment growth in excess of 40.0 percent. High tech employment shifted negatively in the large, adjacent, nonmetro counties, while increasing rapidly in the small, adjacent and not-adjacent counties

The type of high tech industries locating in nonmetro areas also varied by region and by county characteristics. Nonmetropolitan counties adjacent to SMSAs and rural areas in the New England and Pacific states were successful in attracting high technology manufacturers which were in the innovative stage of their product life cycle. The slowly growing, lower labor-skilled, mature, high technology industries shifted employment primarily to the non-adjacent counties and rural areas in the southern and plains states. This is consistent with the product-life-cycle theory of spatial decentralization. Employment in mature, high technology industries is shifting to areas with relatively low land and labor costs, while industries in their growth and innovative stages are remaining close to the sources of skilled labor and specialized inputs.

Finally, an econometric analysis of county-level employment for high tech manufacturers in the west confirms earlier observations for aggregated data. Employment in the primarily innovative firms was positively correlated with county population, population growth rate, proximity to metropolitan areas, and proximity to the west coast. Thus, the western nonmetropolitan high tech firms have demonstrated a reluctance to locate far from the major high tech centers in the west.

The implications of this study for the potential of high technology industries as a source of nonmetropolitan employment are generally positive. Many high technology manufacturers have decentralized production activities and nonmetropolitan employment in this sector has increased rapidly. Moreover, the attractiveness of rural locations to these manufacturers should increase as these industries evolve through their product life cycles and production processes and become less skilled-labor intensive. However, despite the indications that high tech industries are a viable source of employment for rural areas, most nonmetropolitan communities should not concentrate their industrial inducement efforts on this sector. First, high technology industries constituted less than 25 percent of the nation's employment in manufacturing and business services, and the competition for new plants or relocations will be intense. Second, high technology manufacturers in the innovative stage of their product life cycles (generally the more "glamorous" industries) have demonstrated a reluctance to shift production activities to nonmetropolitan locations distant from urban centers. Finally, high technology industries locating in geographically isolated rural communities are likely to be in the mature stage of their product life cycle. These slowly growing, highly standardized, mature firms are not likely to generate community development impacts that are very different from those of traditional nonmetropolitan manufacturers.

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